

[Document Type] Claims

[Claim 1] An exposure apparatus that exposes a substrate by emitting exposure light onto the substrate through a projection optical system and a liquid, comprising:

a detection apparatus that detects whether the liquid is present on an object,
5 which is disposed lower than a front end of the projection optical system.

[Claim 2] An exposure apparatus according to Claim 1, wherein:

said detection apparatus has an emitting portion that emits detection light and a light receiving portion disposed at a predetermined position with respect to the detection
10 light.

[Claim 3] An exposure apparatus according to Claim 2, wherein:

said detection light is emitted from said emitting portion to a plurality of positions, and at least one of a size and a shape of the liquid is obtained based on a light
15 receiving result of said light receiving portion.

[Claim 4] An exposure apparatus according to Claim 2 or 3, wherein:

the detection is performed while relatively moving the detection light of said detection apparatus and said object.
20

[Claim 5] An exposure apparatus according to Claim 4, wherein:

said object is movable with respect to said projection optical system.

[Claim 6] An exposure apparatus according to Claim 5, wherein:

25 said object includes at least one of said substrate, a substrate stage that is

movable and holds said substrate, and a predetermined member on the substrate stage.

[Claim 7] An exposure apparatus according to any one of Claims 2 to 6,
comprising:

5 a bending portion that bends an optical path of the detection light of said
detection apparatus.

[Claim 8] An exposure apparatus according to any one of Claims 2 to 7, wherein:
the detection light of said detection apparatus is emitted substantially parallel to
10 a surface of said object.

[Claim 9] An exposure apparatus according to Claim 8, wherein:
whether the liquid is present in an optical path of the detection light is
determined based on a light receiving result of said light receiving portion.
15

[Claim 10] An exposure apparatus according to Claim 8 or 9, wherein:
the detection light passes through an area away from the surface of said object
by 5.5 mm or less than 5.5 mm.

20 [Claim 11] An exposure apparatus according to any one of Claims 2 to 10,
wherein:
a position of the liquid on said object is obtained based on a light receiving
result of said light receiving portion.

25 [Claim 12] An exposure apparatus according to any one of Claims 2 to 11,

wherein:

said detection apparatus emits the detection light to an immersion area of the liquid formed between said projection optical system and said object.

- 5 [Claim 13] An exposure apparatus according to any one of Claims 2 to 7, wherein:
said detection apparatus emits the detection light to a surface of said object.

- [Claim 14] An exposure apparatus according to Claim 13, wherein:
said light receiving portion receives light from the surface of said object, and
10 the liquid on the surface of said object is detected based on the light receiving result.

- [Claim 15] An exposure apparatus according to Claim 13 or 14, wherein:
the surface of said object irradiated by the detection light includes a recessed
portion formed on said object.

15

- [Claim 16] An exposure apparatus according to Claim 15, wherein:
the recessed portion is provided to a substrate stage that is movable and holds
said substrate, and a substrate holder that holds said substrate is disposed in the recessed
portion.

20

- [Claim 17] An exposure apparatus according to Claim 16, wherein:
the emission of the detection light to said substrate holder is performed before
loading the substrate on said substrate holder.

- 25 [Claim 18] An exposure apparatus according to any one of Claims 2 to 17,

wherein:

the detection light is infrared light of a predetermined wavelength.

[Claim 19] An exposure apparatus according to any one of Claims 2 to 18,

5 wherein:

the detection light includes a sheet light flux emitted so that an area of the liquid which is equal to or greater than a predetermined size is covered with the sheet light flux.

10 [Claim 20] An exposure apparatus according to any one of Claims 1 to 19,

comprising:

a liquid supply mechanism that supplies the liquid; and

a liquid recovery mechanism that recovers the liquid;

wherein an operation of at least one of the liquid supply mechanism and the
15 liquid recovery mechanism is controlled based on a detection result of said detection apparatus.

[Claim 21] An exposure apparatus according to Claim 20, wherein:

the supply of the liquid by said liquid supply mechanism is stopped if it is
20 determined that the detection result of said detection apparatus is abnormal.

[Claim 22] An exposure apparatus according to any one of Claims 1 to 21,

wherein:

an exposure operation is controlled based on a detection result of said detection
25 apparatus.

[Claim 23] An exposure apparatus according to any one of Claims 1 to 22,
wherein:

a warning is issued if it is determined that a detection result of said detection
5 apparatus is abnormal.

[Claim 24] An exposure apparatus that exposes a substrate by emitting exposure
light onto the substrate through a projection optical system and a liquid, comprising:

a detection apparatus having an emitting portion that emits detection light to an
10 immersion area formed between the projection optical system and an object disposed on
an image plane side of the projection optical system, and a light receiving portion that is
disposed at a predetermined position with respect to the detection light, wherein the
detection apparatus obtains at least one of a size and a shape of the immersion area based
on a light receiving result of the light receiving portion.

15

[Claim 25] An exposure apparatus according to Claim 24, wherein:

at least one of the size and the shape of said immersion area is obtained based
on the light receiving result of the detection light emitted to a plurality of positions in
said immersion area.

20

[Claim 26] An exposure apparatus according to Claim 24 or 25, wherein:

a detection by said detection apparatus is performed in parallel with the
exposure of said substrate.

25 [Claim 27] An exposure apparatus according to any one of Claims 24 to 26,

wherein:

the detection light is emitted to the vicinity of an edge portion of said immersion area.

5 [Claim 28] An exposure apparatus according to any one of Claims 24 to 27,
wherein:

the detection light is emitted to each of a plurality of positions in the vicinity of an edge portion of said immersion area.

10 [Claim 29] An exposure apparatus according to Claim 28, wherein:
optical paths of a plurality of beams of the detection light emitted to the vicinity of said edge portion are set in accordance with a target shape of said immersion area.

[Claim 30] An exposure apparatus according to Claim 28 or 29, wherein:
15 at least two of said plurality of beams of the detection light are emitted to the vicinity of edge portions on both sides of said immersion area, respectively.

[Claim 31] An exposure apparatus according to any one of Claims 24 to 30,
comprising:

20 a liquid supply mechanism that supplies the liquid; and

a liquid recovery mechanism that recovers the liquid;

wherein an operation of at least one of the liquid supply mechanism and the liquid recovery mechanism is controlled based on a detection result of said detection apparatus.

[Claim 32] An exposure apparatus according to Claim 31, wherein:
the supply of the liquid by said liquid supply mechanism is stopped if it is
determined that the detection result of said detection apparatus is abnormal.

5 [Claim 33] An exposure apparatus according to Claim 31 or 32, wherein:
the supply of the liquid by said liquid supply mechanism is stopped if said
immersion area of the liquid formed between the projection optical system and the
substrate has become, or larger than a predetermined size.

10 [Claim 34] An exposure apparatus according to any one of Claims 24 to 33,
wherein:
the detection light is infrared light of a predetermined wavelength.

[Claim 35] An exposure apparatus according to any one of Claims 24 to 34,
15 wherein:
the detection light includes a sheet light flux emitted so that an area of the
liquid which is equal to or greater than a predetermined size is covered with the sheet
light flux.

20 [Claim 36] An exposure apparatus that exposes a substrate by emitting exposure
light onto the substrate through a projection optical system and a liquid, comprising:
a shape detection apparatus that obtains a shape of the liquid on an object which
is movable on an image plane side of the projection optical system.

25 [Claim 37] An exposure apparatus according to Claim 36, wherein:

said detection apparatus having an emitting portion that emits a plurality of detection light arrayed in a vertical direction with respect to a surface of said object, and a light receiving portion that is disposed at a predetermined position with respect to the detection light, wherein the detection apparatus obtains the shape of the liquid based on
5 a light receiving result of the light receiving portion.

[Claim 38] An exposure apparatus according to Claim 36 or 37, wherein:
an affinity of the liquid for said object is obtained based on said obtained shape of the liquid.

10

[Claim 39] An exposure apparatus according to any one of Claims 36 to 38, wherein:
a contact angle of the liquid with respect to said object is obtained based on said obtained shape of the liquid.

15

[Claim 40] An exposure apparatus according to Claim 39, wherein:
said detection apparatus detects a height of the liquid on said object, and obtains the contact angle of the liquid with respect to said object based on a result of the detection.

20

[Claim 41] An exposure apparatus according to any one of Claims 36 to 40, wherein:

said object includes at least one of said substrate, a substrate stage that holds said substrate, and a predetermined member of the substrate stage.

25

[Claim 42] An exposure apparatus that exposes a substrate by emitting exposure light onto the substrate through a projection optical system and a liquid, comprising:

a detection apparatus that detects a contact angle of the liquid, on an upper surface of a substrate stage that holds the substrate, with respect to the upper surface of the substrate stage.

[Claim 43] An exposure apparatus according to Claim 42, wherein:

the contact angle of the liquid with respect to the upper surface of said substrate stage is obtained periodically.

[Claim 44] An exposure apparatus according to Claim 42 or 43, wherein:

the upper surface of said substrate stage includes a surface of a predetermined member which is replaceably disposed on said substrate stage, and the predetermined member is replaced based on said detected contact angle.

[Claim 45] An exposure apparatus according to any one of Claims 42 to 44, wherein:

the upper surface of said substrate stage includes a surface of the substrate held by said substrate stage.

[Claim 46] An exposure apparatus according to any one of Claims 42 to 45, comprising:

a liquid supply mechanism that supplies the liquid; and

a liquid recovery mechanism that recovers the liquid;

wherein an operation of at least one of the liquid supply mechanism and the

liquid recovery mechanism is controlled based on said detected contact angle.

[Claim 47] An exposure apparatus according to any one of Claims 42 to 46,
wherein:

- 5 said detection apparatus detects the contact angle by emitting infrared light of a
predetermined wavelength to the liquid on said substrate stage.

[Claim 48] A device manufacturing method using an exposure apparatus
according to any one of Claims 1 to 47.